EIDER BREEDING POPULATION SURVEY
ARCTIC COASTAL PLAIN, ALASKA
2001

by:
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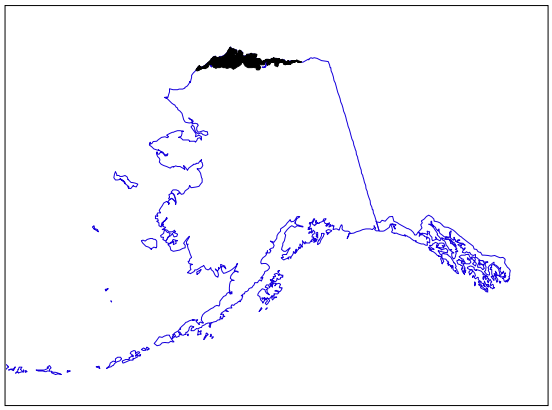

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December 17, 2001

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Abstract. The North Slope Eider Survey has been conducted for 10 consecutive years, 1992 to 2001. Survey techniques have remained constant, except that since1997 observations have been dictated directly into computers that were connected to an onboard GPS, giving precise coordinates for all observations. The survey pilot was the same person for all years, while the copilot/observer changed in 1997 and again in 2000. In 1998 the survey area was split into 11 geographical strata based on habitat features and the boundaries of the National Petroleum Reserve of Alaska, northeast planning area. Data were re-analyzed for all years using the new stratification, which slightly improved precision of the estimates and facilitated area-wise comparisons. The spring thaw was slightly later than average in 2001, and sea duck breeding phenology was delayed a few days. The 2001 breeding index for spectacled eiders was 7,370. This is slightly above the long-term average of 7,072,but there is still a non-significant downward trend (annual growth rate = 0.982). The King eider index was 17,031, which is the highest on record, well above the long-term average of 12,913, and continued the non-significant increasing trend (annual growth rate = 1.031). However, we believe the king eider index was inflated this year by the presence of transient birds, as suggested by unusually high numbers of paired and flocked birds in our phenology reference area early in the survey period, which dropped off rapidly thereafter . Significant long term increases were noted for arctic terns (annual growth rate 1.075) and black brant (annual growth rate 1.108), while indices for red-throated loons have declined (annual growth rate 0.907). Indices for other species have not changed significantly since 1992. We conducted replicate surveys of a small reference area in the western portion of the survey area during 1999 through 2001, to help with survey timing and evaluation. While inconclusive due to the possible presence of transient birds, results suggested that timing was appropriate for spectacled eiders in all three years, in the western portion of the survey area at least. For king eiders highly variable results suggested a more mobile population during the survey, and the reference area provided little help with survey timing for that species. In 2001 we conducted a concurrent survey of a 270 km^2 subsample of the fixed-wing sample, using a helicopter and an adaptive survey technique to estimate the proportion of eiders, long-tailed ducks, and loons within the transect not detected by the fixed-wing crew. This study produced apparently-erroneous results indicating a flawed technique, and was not used to adjust survey data.

Key Words: Eider, spectacled, *Somateria fischeri*, Steller's, *Polysticta stelleri*, king, *Somateria spectabilis*, breeding, population, Aerial, survey, waterfowl, arctic, Alaska

INTRODUCTION

A comprehensive aerial waterfowl breeding population survey was initiated in the Arctic Coastal Plain of Alaska in 1986, and has continued annually to the present time. That survey, however, conducted from late June through early July, is phenologically too late for an accurate assessment of eiders, the males of which typically begin to depart the breeding grounds for the post-nuptial molt by about 20 June. Accordingly, in anticipation of the listing of spectacled and Steller's eiders under the endangered species act, a second, earlier survey was initiated in 1992 to obtain an accurate annual population index and distributional data for these two species. The latter survey has consistently provided useful data for spectacled eiders, king eiders, and several other species of waterfowl, but has proven inadequate in sampling intensity for Steller's eiders, which are present on the arctic coastal plain in very low densities. The survey has been conducted annually using essentially the same design since it's inception, though improvements in data collection technology and analysis have been added along the way. This report includes methods and results for the 2001 survey, and summaries for 1992-2001.

STUDY AREA AND METHODS

Aerial crew for 2001:

Pilot/observer: **William Larned**, *Migratory Bird Management, Soldotna*

Observer: **Julian Fischer**, *Migratory Bird Management, Anchorage*

Survey techniques followed those described by Butler et al. (1995a). Transects were oriented roughly east-west, and consisted of computer-generated segments of great-circle routes, for compatibility with Global Positioning System (GPS) navigation. The lines, along with end-point coordinates, distance figures and segment end indicators, were machine-plotted on 1:250,000 scale U.S. Geological Survey topographic maps, which were used for navigation. Transects were spaced systematically from a randomly-selected starting point, at intervals of 2.3 km. Every fourth transect was flown on a given year, with the sampling frame shifted incrementally each year, requiring 4 years for coverage of all transects. Thus the transects flown in 1997 were duplicates of those flown in 1993. However, the GIS base map for the survey area boundary was redrawn in 1998, and the survey lines for that year approximated those of 1997. The annual incremental frame shift was then resumed based on the new coverage. In 1998 we split the survey area into 11 geographical strata, based on a habitat classification map developed by Ducks Unlimited, and the boundaries of the NPRA Northeast Planning Area (Fig. 1). All results presented in this report, including those from previous years, were calculated using this stratification, so slight differences may be seen when comparing data herein with corresponding figures from earlier reports. Advantages of this stratification system are that it decreased the variance for estimates of eiders and most other waterbirds, and it facilitates comparisons between different geographic areas within both the Eider Survey area and the area of the Standard ACP Breeding Population Survey (the strata for this survey are a subset of those for the ACP Survey (Fig. 1)). The survey transects flown in 2001 are depicted in Fig. 2. Flight hours required to complete the survey in 2001 totaled 33.8 on transects (table 1), plus 8 for reconnaissance. These hours did not include ferry time to and from the survey area.

We used a Cessna 206 amphibian for all years of this survey. Navigation equipment included a GPS, a radar altimeter, and a Horizontal Situation Indicator (HSI) slaved to a remote compass, with integrated GPS course deviation indicator. We flew along the transect center lines at 30 m altitude and 176±19 $km \cdot hr^{-1}$ ground speed, while both the pilot and the right-hand observer recorded all water birds, avian predators and shorebirds observed within 200 m of either side of the aircraft. Observers used tape markers placed on the aircraft lift struts to aid in estimating the outer transect (strip) boundaries. The marker locations of 8.5 degrees below the horizontal at eye level were determined using a clinometer. We recorded bird observations as singles, pairs and flocked birds according to the protocol used for the North American Waterfowl Breeding Population Survey (U. S. Fish and Wildlife Service and Canadian Wildlife Service 1987). We actively minimized observations in the "unknown eider" category by occasionally leaving the transect centerline to confirm identification of eiders. This was done primarily when training new observers. Additional birds seen within the transect as a result of these maneuvers were not included in the data set.

In 1997 and 1998 a new data acquisition system was used, in which observations were entered vocally into a microphone connected to a laptop computer. The computer also received GPS position data concurrently via a serial connection from the panel-mounted GPS receiver. These two inputs resulted in a sound file (.wav format) with a linked .pos file containing location, date and time. To create a final data file, the observer played back the sound file on the computer and entered the species name and group size for each observation, using a custom transcribing program. The transcription program produced an ASCII text file, each line containing a single observation including species code, group size, and latitude-longitude coordinates, as well as date, time, stratum and transect identifiers. Additionally, the system output a track file which is a list of position coordinates for the aircraft recorded every five seconds during flight. A separate computer was used by each observer, and each computer was connected to the GPS and supplied with power via a 28-volt DC to 110-volt AC inverter connected to the aircraft's electrical system. The software used for this system was developed by John I. Hodges, U.S. Fish and Wildlife Service, Migratory Bird Management, 3000 Vintage Blvd., Suite 240, Juneau, AK 99801-7100. The resultant files may be used to produce map, tabular and other products describing population trends and distribution of the various taxa surveyed.

Waterfowl observation data were treated according to protocol described for the standard North American Waterfowl Breeding Population Surveys (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987). That is, for all ducks except greater scaup, the indicated total population index is calculated as twice the number of males observed as singles, in pairs, and in groups of males up to four, plus birds in flocks of 5 or more males or mixed sex. For scaup (which are known to have sex ratios strongly skewed toward males) and all other birds, singles are not doubled and the population index is based on total birds observed.

Inaccuracies in this survey come from three sources: sampling error due to the nonrandom distribution of birds within the sample, timing of the survey relative to bird breeding phenology, and variations in detection of birds in the sample. Sampling error is addressed using ratio estimate procedures described by Cochran (1977), and the calculated variance is used to produce 95% confidence intervals for the population estimates. Survey timing is designed to coincide with the presence of spectacled and king eider males, which are normally present on the breeding grounds only from arrival until shortly after nest initiation. Variations in timing of arrival and departure between individual spectacled eider males on a study area in the Prudhoe Bay vicinity suggest that there may be few if any days when all breeding males are present in the survey area at the same time, especially in years of early spring melt (Troy 1997). Median nest initiation dates at Prudhoe Bay from 1993 to 1996 varied from 7 to 16 June (average 1982-96 = 15 June), and telemetry data suggest that male departure begins within about 3 days of that date,

and is more synchronized in the years when it commences later. Most males have departed the area by 20 to 25 June. It is unknown how phenology in the Prudhoe Bay area compares with other parts of the Arctic Slope. King eider phenology is similar, but the period of male presence is normally more protracted and possibly less synchronous, probably because king eiders utilize a greater diversity of wetland types. In general in the high arctic, king eiders begin to nest in the last half of June, about 2-3 weeks after arrival (Bellrose 1976). Departure of males on Bathurst Island, N.W.T., Canada, came rather abruptly and synchronously from one week to 10 days after clutch initiation (Lamothe 1973). For this survey we assumed that proper timing for spectacled eiders is adequate for king eiders as well. Our procedure for determining proper survey timing consisted of the following: 1. We monitored weather and ice and snow cover conditions, planning to arrive in the survey area when ponds and tundra vegetation are available to nesting eiders over most of the arctic slope. 2. We contacted biologists in Prudhoe Bay and Barrow for their observations on eider phenology. 3. We flew reconnaissance surveys to determine the distribution of spectacled eider pairs. When eider pair distribution seemed about normal (subjectively based on experience) within the Prudhoe Bay area and in the central and western arctic slope, we began the survey. Some other waterbird species are later and more variable in their arrival, and this survey generally does not target their peak in abundance. It is assumed that the later standard waterfowl breeding population survey is more accurately timed for dabbling ducks, loons and perhaps some of the divers. White-fronted and Canada geese are more numerous later in June also, but this may result from an influx of non-breeding flocked birds, which inflate the breeding index.

We used two methods to determine retrospectively the appropriateness of the timing of our survey. First, beginning in 1997 we used a ratio of lone drakes (singles) to total indicated pairs (singles plus pairs) averaged over the entire survey sample as an index for spectacled and king eiders, to help compare survey timing between years for these primary target species (Larned and Balogh 1997). The assumption inherent in this index is that the proportion of lone or grouped males in the surveyed population will increase as the season progresses because males remain visible as lone males on breeding ponds as females spend more time with nesting activities. While we feel this is valid with many ducks, with eiders there is a greater tendency for males to leave the breeding grounds immediately after nest initiation than with most other ducks, making many lone males unavailable for observation. Therefore, while we feel this index is useful in concert with other indicators of phenology, it could be misleading when considered independently.

For the second method, beginning in 1999 we added a phenology reference area. This study area consists of a 97.4 km^2 irregular polygon located about 10 km northwest of our fuel cache at Atqasuk Village (Fig. 3). In 1999 and 2000 we flew this polygon as often during the survey as practicable, collecting bird data as in the operational survey. We flew a set of transects in a roughly parallel north-south but adaptive fashion, maneuvering the aircraft to most efficiently cover all water bodies, given current conditions of wind and sun angle etc. The coverage was designed as a comparable 100 percent coverage. Data consisting of daily counts of total birds and relative numbers of singles, pairs and flocked birds enabled us to attempt to evaluate our survey timing in relation to apparent breeding phenology. We did not use these data to adjust our survey data in any way to compensate for errors resulting from inappropriate survey timing.

In 2001 we decided that we had not been obtaining a complete coverage, and the adaptive transects and therefore likely our coverage varied from survey to survey. Therefore, we attempted to further standardize coverage by flying a set of 14 pre-drawn (electronic) north-south transects using our standard survey technique, which produced a standardized 50 percent coverage (Fig. 4).

We have made little progress in addressing inaccuracies in detection. The survey is assumed to track the population of birds that visits the survey area during the breeding season. Of this total, some birds will not be represented in the sample because: 1. They have not yet arrived in the survey area; 2. They have left the survey area; 3. They have departed the sample transect before detection, due to disturbance by the aircraft; 4. They are not visible from the aircraft (hidden by vegetation, terrain, aircraft fuselage etc.); 5. They are misidentified; 6. The observers fail to see them due to any of several variables of detection bias, such as fatigue, experience level, visual acuity differences, distractions, sunlight conditions, presence or absence of snow and ice, bird behavior, and work load (density of other birds or objects). As previously mentioned, we have attempted to minimize the effects of numbers 1 and 2 by proper survey timing. Aerial survey crews working in other areas have attempted to compensate for the net effect of these variables by ground-truthing a sub-sample using ground or helicopter crews (US Fish and Wildlife Service and Canadian Wildlife Service 1987), and using those data to calculate visibility ratios to adjust operational survey data. During the 2001 survey we conducted a fixed-wing/helicopter detectability study covering a 270 km^2 subset of our operational transects. As we will discuss later in this report, the results of this study were not satisfactory; therefore we are still left with an unadjusted annual index to abundance, for which we strive diligently to minimize the effects of the variables of phenology and observer bias.

RESULTS AND CONCLUSIONS

Habitat conditions and survey timing

Archived weather data are scarce for the survey area. The Umiat station was not active in 2001 (we expect it will be in 2002), and the only two stations recording data were Barrow and Kuparuk. Availability of final monthly summaries is several months behind, so we have no official data on temperatures and precipitation as of this writing. However, reconnaissance and survey flights beginning on 9 June revealed an average to slightly late spring over much of the North Slope. The shallow wetlands around Atqasuk and Prudhoe Bay began to open at about that date, and temperatures often in the mid to upper 50's F completed the thawing of most of these ponds by 13 June. Deeper ponds and most wetlands along the Chukchi coast and in the Teshekpuk Lake area remained wintry until mid-June at least. The tundra vegetation was only about 10 percent snow-covered when we arrived on 9 June, and the remaining snow and ice melted quickly over the next 5 days. Water levels were normal to slightly high west of the Ikpikpuk River, and unusually low east of the Colville to the Canning River. Phenology of several important waterfowl species seemed a bit late during the survey period. During our reconnaissance flights of 9 and 10 June we saw an unusually high proportion of king eiders and long-tailed ducks in flocks. Overall abundance of these two species also seemed higher than normal in the western portions of the survey area, then subsequently dropped off (Table 4), suggesting the presence of transient birds early in the survey period. We did not see flocking behavior in spectacled eiders, and the drop off in numbers was less pronounced. The ratio of lone males to total males for king eiders of 0.14 was by far the lowest since the survey's inception in 1992, and the ratio for spectacled eiders of .37 was the second lowest on record (Table 2), which support our suspicion that the survey was timed relatively early. Our experience since 1992 suggests that the annual variation in breeding phenology, of sea ducks at least, cannot always be explained entirely by habitat availability. Probably the factor that most confuses the issue is the presence of transient birds, particularly in the western portions of the survey area. This could easily be causing a higher west/east gradient of bird density, in certain years at least, and possibly some double counting as birds make major eastward movements during the survey.

Unfortunately the extremely short residence time of spectacled eider males on the breeding grounds does not give us much leeway in our survey window.

Phenology reference area surveys

This year these surveys were flown twice immediately before the main survey began, twice on the last two days of the survey, then once on 26 June, during the later Standard Breeding Population Survey (Table 4). Results generally fit the pattern noted in the 2000 report: peak numbers occurred on different dates for different species. Numbers of pacific loons, Sabine's gulls, arctic terns, and pintails increased sharply after 10 June, while those of long-tailed ducks, spectacled eiders , king eiders, and white-fronted geese trended downward during the survey period. Interestingly, Long-tailed duck numbers increased again after the eider survey to reach its highest level on 26 June.

Population estimates and breeding distribution for selected species

Table 5 presents tallies for sample data (single, pair and flocked bird totals in the sample), as well as estimates calculated from these data, for 2001. Table 6 presents long-term average breeding population point estimates and densities for each species by stratum, and is referenced to figure 1. Table 7 presents long-term population trend slopes, growth rates, and estimates of the number of years required to detect a trend equivalent to a 50 percent growth or decline in 10 years. Figures 8-31 include stacked bar graphs depicting annual sample composition (singles, pairs, flocks <5, flocks >= 5), annual population indices with 95percent confidence limits based on within-year sampling error among transects as stratified by 11 physiographic regions, and average annual growth rate as determined by log-linear regression. Annual indices and other values are calculated for singles and pairs only and for total indicated birds.

In general 2001 indices were not remarkable, i.e. for most species they were close to the long-term average and/or the trend line (Figs. 8-31). Notable exceptions are glaucous gull (Fig. 12), which was well below the trend line and the estimates from the previous three years; Pintail (Fig. 17), which was 10,000 birds below the average, but still well above the three lowest years; and king eider (Fig. 21), which was the highest on record for this survey. We suspect that transient king eiders may have inflated the counts based on the abundance of large flocks early in the survey period and a sharp decline through the period within the phenology reference area.

After 10 years of surveys only three species indicated a trend significantly different from 1.0 at the 90% level: Red throated loon (Fig. 10) indices have declined at the rate of 0.907 (90% CI = 0.849-0.970), while arctic tern (Fig. 14) indices have increased (growth rate = 1.075, 90% CI = 1.053-1.096), as have those of black brant (Fig. 27, growth rate = 1.108, 90% CI = 1.024-1.199). Species showing non-significant downward trends are: yellow-billed loon, sabine's gull, spectacled eider, Canada goose, and snowy owl (Table 7). Species showing non-significant upward trends are: pacific loon, jaegers, glaucous gull, red-breasted merganser, northern shoveler, northern pintail, greater scaup, long-tailed duck, king eider, Steller's eider, white-winged scoter, snow goose, white-fronted goose, tundra swan, unidentified small shorebirds, and short-eared owl (Table 7).

With alpha and beta levels set at 0.10, if the population began to grow or decline with a slope of 0.0693 (a 50% change in numbers over 10 years) and the estimated sampling error CV was accurate, the minimum number of survey years needed to detect a slope significantly different from 0.0 was calculated for each species. Significant change in Pacific Loon, Long-tailed Duck, and small shorebird population

could be detected within 5 years; while northern pintail and white-fronted goose would take 6 years; Jaegers, Arctic tern and tundra swan would take 7 years; red-throated loon, Sabine's gull, spectacled eider, and king eider, would take 8 years; glaucous gull would take 9 years, and yellow-billed loon, greater scaup, Steller's eider, white-winged scoter, snow goose, Canada goose, black brant, and snowy owl would take 10 years or more (Table 7).

Steller's eiders that breed on the North Slope are at densities so low that this survey cannot obtain a sample large enough to determine trends within a useful time frame (Table 7). Our sample included only 33 indicated Steller's eiders in 1999, none in 2000 (Larned et al. 2001), and 18 in 2001 (Table 5). Alaska Biological Research (ABR), Inc., under contract with the U. S. Fish and Wildlife Service, conducted a survey with a much higher sampling intensity (50 percent coverage) within a 2757 km^2 study area immediately south of Barrow, in both 1999 and 2000. They observed 112 indicated birds in 1999, for a density of 0.08 indicated birds per km^2, 110 indicated birds in 2000 (density 0.08) and only 44 indicated birds in 2001 (density 0.03) (Ritchie and King 2001, Ritchey pers. comm.). By comparison, within the same area we saw 13 indicated birds in 1999 (sampling intensity 4.5%, density 0.10 indicated birds per $km^{2)}$, no birds in 2000 (sampling intensity 3.8%), and 16 indicated birds in 2001 (sampling intensity 4.2%, density 0.14).

Distribution of observations of spectacled, king, and Steller's eiders for 2001 is illustrated in Figs. 5, 6, and 7, respectively. Spectacled eider and king eider distribution are grossly similar to prior years, except that there were more spectacled eider observations than usual east of Harrison Bay (in the "oil patch"). Not surprisingly, all but one of the Steller's eider observations were in the Barrow vicinity, while the other observation was a few km northwest of Atqasuk. A 501 km^2 area immediately south of Atqasuk was surveyed intensively by the ABR, Inc. crew in 2000 and 2001, and no Steller's eiders were observed in either year (Ritchey and King 2001, Ritchey pers. comm.).

Helicopter detectability study

A detection rate study was completed using a helicopter to survey a subset of transects from the operational survey. The objective was to intensively and adaptively cover all wetlands within this subset, using the same transect width as the fixed-wing survey, in an effort to count all eiders, long-tailed ducks, and loons, thus providing "ground truth" data for the determination of proportions of birds present on the transect that are detected and recorded by the fixed-wing observers. These data were to be used to adjust fixed-wing data, converting the annual waterfowl indices into population estimates. This helicopter technique has been used for several years on the annual North American Waterfowl Breeding Population Surveys in roadless areas of Canada and Alaska, as a practical alternative to ground-based surveys, with apparently satisfactory results. Preliminary results from our study, however, appear unreasonable; i.e. most of the fixed-wing counts were higher than the corresponding helicopter counts. So far we have been unable to explain these apparent discrepancies (though there were some initial malfunctions of the GPS-linked data recording system in the helicopter). Therefore, we have not incorporated detection rate correction factors into our data analysis this year. A detailed report on the helicopter study will be completed later this year.

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The authors would like to thank Julian Fischer for his excellent work as observer for the second year on this survey, and Ed Mallek and Dennis Marks for conducting a reference area replicate during their

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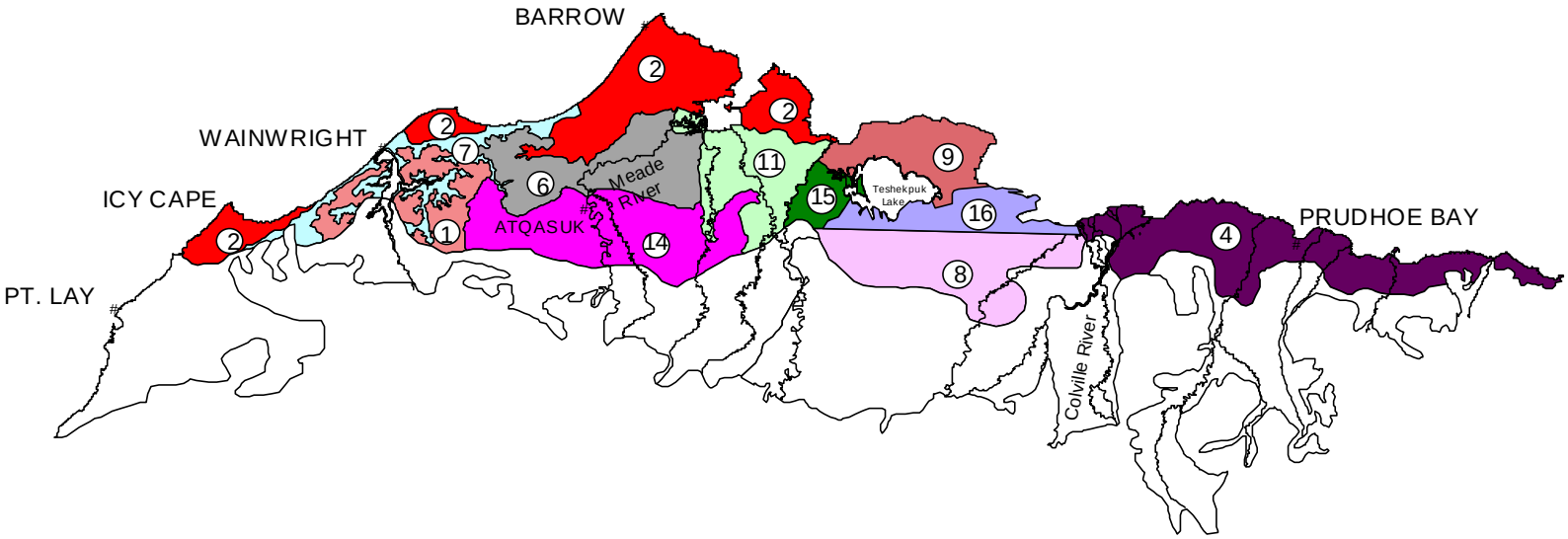

Figure 1. Survey strata for the North Slope Eider Survey, Alaska, with major hydrographic and cultural features. Unnumbered units south of the eider survey area are strata surveyed by the Standard Breeding Population Survey in late June - early July.

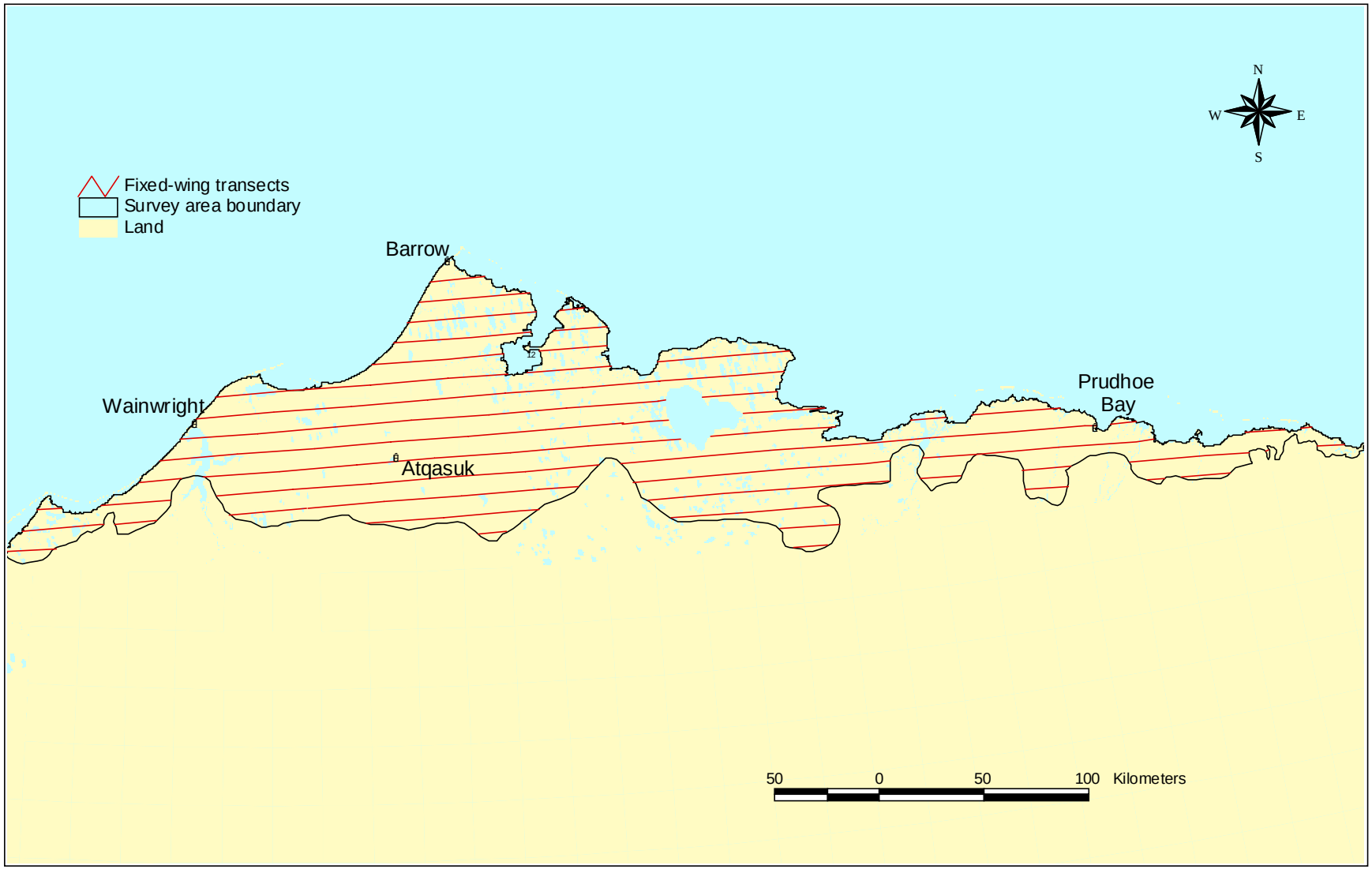

Figure 2. Aerial transects flown during the eider breeding population survey, Alaska, June 11-17, 2001

Table 1. Survey design, North Slope Eider Survey, 1992-2001.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Recon. dates (June)	NA	8	10-12	8	6	5-10	6	8	11	9-10
Survey dates (June)	20-29	9-18	12-19	9-18	7-17	11-20	6-15	11-17	11-18	11-17
Number of transects	63	272	267	268	261	96	132	121	102	130
Total transect length (km)	2,784	3,146	3,193	3,248	3,199	3,232	3,527	3,478	2,905	3,200
Sample area (km^2)	1,113	1,253	1,277	1,300	1,279	1,292	1,410	1,391	1,162	1,280
Survey area (km^2)	30,755	30,755	30,755	30,755	30,755	30,755	30,755	30,755	30,755	30,755
Sample % of survey area	3.6	4.1	4.2	4.2	4.2	4.2	4.6	4.5	3.8	4.2
Pilot/observer[1]	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
Observer[2]	GB	GB	GB	GB	GB	TT	TT	TT	JF	JF
Survey flight hours	40.2	50.5	50.3	54.5	53.1	50.2	49.0	51.5	41.7	33.8

1. BL:Bill Larned 2. GB:Gregory Balogh, TT:Tim Tiplady, JF:Julian Fischer

Table 2. Ratio of total lone males to total males (lone males plus males in pairs) in the sample for king eider and spectacled eider, 1992-2001, North Slope Eider Survey, Alaska. We suggest that higher numbers indicate later average breeding phenology for the survey.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Avg.
King eider	.54	.21	.31	.33	.58	.27	.48	.25	.32	.14	.34
Spectacled eider	.52	.52	.44	.42	.55	.53	.56	.29	.55	.37	.48

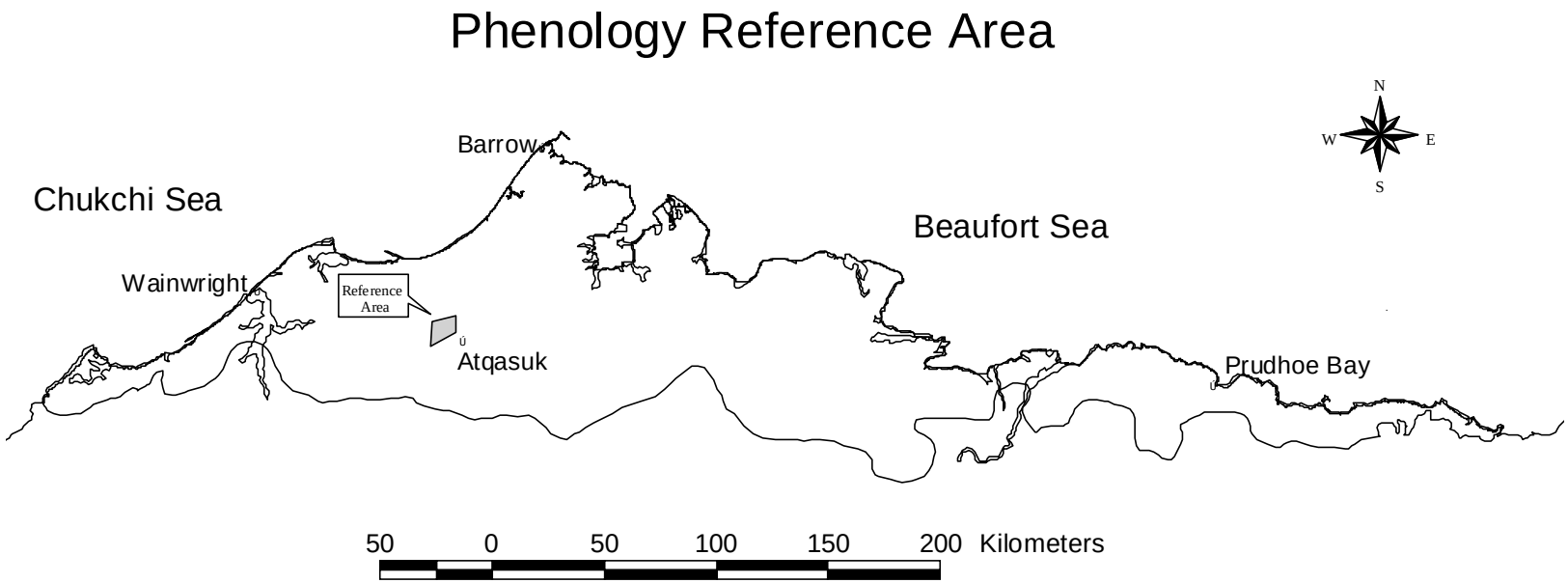

Figure 3. Location of phenology reference area, North Slope Eider Survey, Alaska, June 1999-2001.

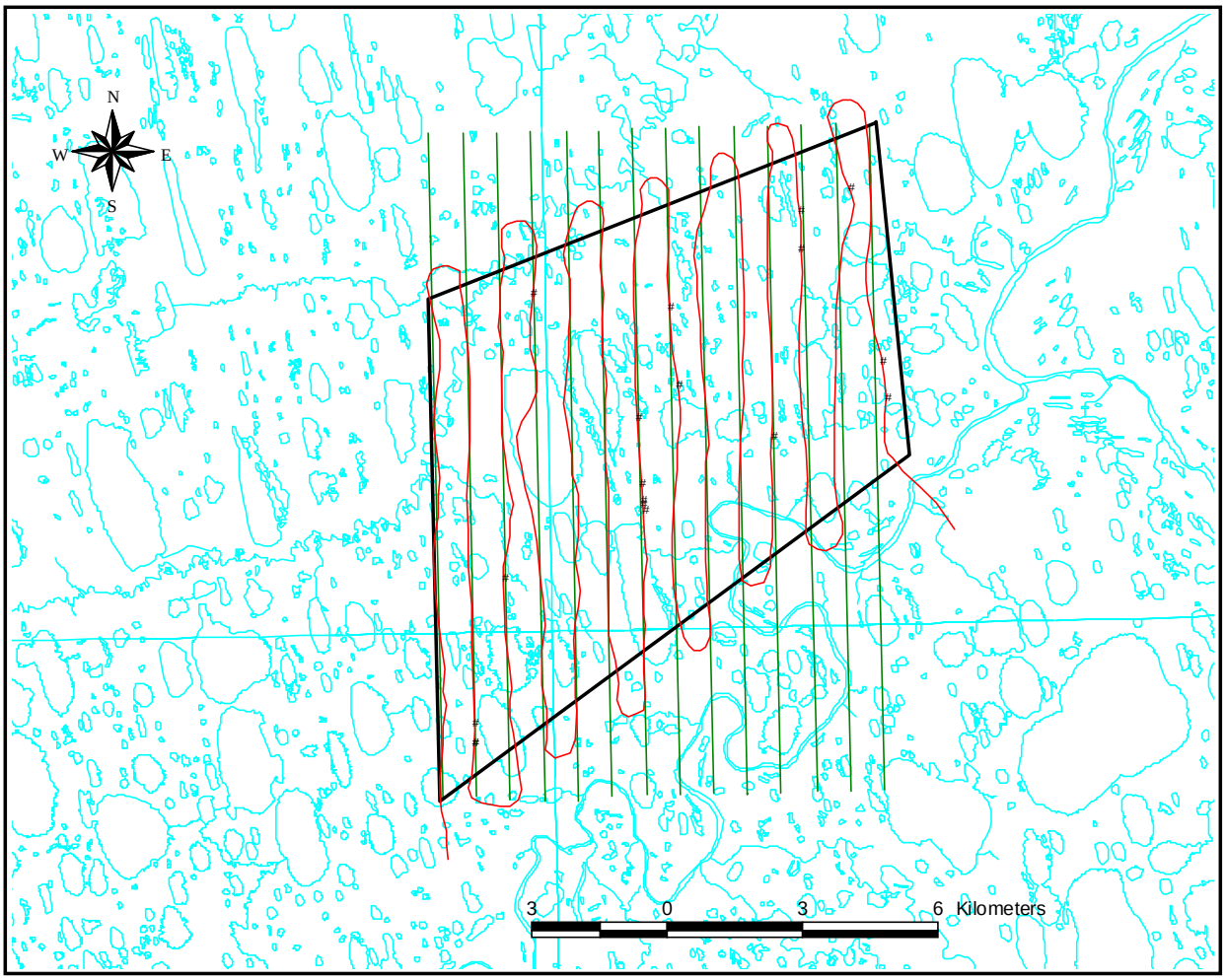

Figure 4. Hydrology, transects (straight green lines), flight path (curved red line), and spectacled eider observations (black dots) from an aerial survey of a 97.4 km^2 phenology reference area, North Slope Eider Survey, Alaska, June 18, 2001.

Table 3. Survey parameters for five replicate aerial surveys of a 97.4 km^2 reference study area located 15 km NW of Atqasuk, Alaska, June 2001.

Date	Pilot	Observer	Start time	Elapsed time min.	Wind spd Knots	Sky cond.
6/9	Larned	Fischer	16:41	79	10	brkn
6/10	Larned	Fischer	15:03	78	10	brkn
6/17	Larned	Fischer	19:27	43[1]	5	ovcst
6/18	Larned	Fischer	09:33	59	10	scat
6/26	Mallek	Marks	15:18	77	5	clear

1. Survey this date not completed: 3 of 14 transects not surveyed.

Table 4. Daily summaries of birds observed within the Atqasuk reference area during June, 2001.

Species	Date	Singles	Pairs	grouped birds	observed total	indicated total
Yellow-billed loon	6/9				2	2
	6/10	1	1		3	3
	6/26	2			2	2
Pacific loon	6/9	16	18		52	52
	6/10	20	20		60	60
	6/17	18	50	5	123	123
	6/18	11	45	3	104	104
	6/26	38	19	11	87	87
Red-throated loon	6/9	1			1	1
	6/26	6	1		8	8
Jaeger spp.	6/9	5	1		7	7
	6/10	6			6	6
	6/17	4			4	4
	6/18	4			4	4
	6/26	2			2	2
Glaucous gull	6/9	4	3	27	37	37
	6/10	7		40	47	47
	6/17	7	3	42	55	55
	6/18	8	1		10	10
	6/26	10			10	10
Sabine''s gull	6/9	9	1		11	11
	6/10	5	5	4	19	19
	6/17	11	11		33	33
	6/18	17	6		29	29
	6/26	10	2	30	44	44
Arctic tern	6/9	11	4		19	19
	6/10	6	8	3	25	25
	6/17	26	4	6	40	40
	6/18	30	5	11	51	51
	6/26	10	2	45	59	59
Red-breasted merganser	6/9		2		4	4
	6/10		1		2	2
	6/26	1			1	2
Northern pintail	6/9	12	11		34	46
	6/10	19	8		35	54
	6/17	30	3		36	66
	6/18	49	6	6	67	116
	6/26	17	2	14	35	52

Species	Date	Singles	Pairs	grouped birds	observed total	indicated total
Scaup sp.	6/9	1	1		3	3
	6/10		1		2	2
	6/17		4		8	8
	6/18	1	1		3	3
	6/26	3	3		9	9
Long-tailed duck	6/9	13	14	8	49	62
	6/10	20	16	8	60	80
	6/17	9	7		23	32
	6/18	10	5		20	30
	6/26	27	16	11	70	97
Spectacled eider	6/9	7	15		37	44
	6/10	11	21		53	64
	6/17	8	4		16	24
	6/18	14	4		22	36
	6/26	3			3	6
King eider	6/9	7	46	4	103	110
	6/10	8	59	10	136	144
	6/17	8	7		22	30
	6/18	16	7		30	46
	6/26	1			1	2
White-fronted goose	6/9	4	86	92	268	268
	6/10	6	80	124	290	290
	6/17	4	27	58	116	116
	6/18	3	47	75	172	172
	6/26	7	12	211	242	242
Tundra swan	6/9	5	2		9	9
	6/10	2	2		6	6
	6/17	6			6	6
	6/18	5	2		9	9
	6/26	2	4		10	10
Swan nest	6/9	1			1	1
	6/10	2			2	2
	6/17	2			2	2
	6/18	1			1	1
Sandhill crane	6/9	1			1	1
	6/10	1			1	1
	6/26	1			1	1

Table 5. Combined observations of birds by pilot and right-hand observer on aerial survey transects sampling tundra habitats on the arctic coastal plain, Alaska, June, 2001, with observable indicated population estimates calculated from these data.

Species	Single	pair	grouped birds	Indicated Total	Density birds·km^{-2}	Pop. Estimate	Pop. Std. Error	%CV
Yellow-billed loon	11	17		45[1]	0.036	1,104	178	16
Pacific loon	160	329	25	843[1]	0.659	20,273	1,210	6
Red-throated loon	27	35	3	100[1]	0.079	2,415	350	15
Jaeger spp.	151	21	12	205[1]	0.160	4,930	629	13
Glaucous gull	187	52	100	391[1]	0.310	9,519	1,227	13
Sabine's gull	96	50	76	272[1]	0.212	6,511	856	13
Arctic tern	206	141	68	556[1]	0.439	13,495	1,292	10
Red-breasted merganser	1	6	3	17[2]	0.013	415	143	35
Am. green-winged teal	3	1		8[2]	0.006	196	95	49
American wigeon	11	21	181	234[2]	0.024	727	798	110
Northern shoveler	3			6[2]	0.005	145	144	100
Northern pintail	533	212	368	1,858[2]	1.442	44,358	3,637	8
Greater scaup	32	75	19	201[1]	0.160	4,918	803	16
Long-tailed duck	261	408	146	1,484[2]	1.158	35,609	2,044	6
Spectacled eider	55	97		304[2]	0.240	7,370	673	9
Common eider	1	2		6[2]	0.005	145	95	65
King eider	57	302	25	743[2]	0.554	17,031	1,585	9
Steller's eider	2	7		18[2]	0.014	433	224	52
Surf scoter			5	5[2]	0.004	121	126	104
White-winged scoter		4		8[2]	0.006	194	89	46
Snow goose		5	149	159[1]	0.124	3,801	1,813	48
White-fronted goose	129	770	2,129	3,798[1]	2.978	91,591	5,403	6
Canada goose	11	21	181	234[1]	0.178	5,483	2,260	41
Black brant	7	23	155	208[1]	0.162	4,802	1,357	28
Tundra swan	150	70	9	299[1]	0.235	7,237	652	9
Sandhill crane	2	2		6[1]	0.005	149	82	55
Unid. small shorebird	607	289	497	1,682[1]	1.318	40,523	2,301	6
Unid. large shorebird	21	7	3	38[1]	0.030	912	135	15
Common raven	3			3[1]	0.002	74	38	52
Short-eared owl	4			4[1]	0.003	98	44	45
Snowy owl	4			4[1]	0.003	97	51	52

1. singles+(2*pairs)+flocked birds 2. 2*(singles+pairs)+flocked birds 3. Black- bellied plover, lesser golden plover, red-necked phalarope, red phalarope, dowitcher spp., ruddy turnstone, dunlin, semipalmated sandpiper, pectoral sandpiper, and others. 4. bar-tailed godwit, hudsonian godwit, whimbrel and others.

Table 6. Average Population indices (upper) and densities (lower) for 11 geographical strata as mapped in figure 1, North Slope eider survey, Alaska, 1992-2001. Largest stratum figures are in bold print.

Stratum description		Wainwright coastal margin	Atqasuk - Kuk River Lake Region	Upper Meade River	Lower Meade River	Barrow - Cape Franklin - Icy Cape	Topagoruk and Chipp Rivers	Western Northeast Planning Area	Middle Northeast Planning Area	Kogru River	Northern Northeast Planning Area	Colville Delta to Sagavanirk tok River	Total North Slope Eider survey
Stratum km^2		2408.2	2098.3	4179.7	3077.9	3884.2	2806.2	729.2	3549.3	1450	1949.5	4622.5	30755
Map reference		7	1	14	6	2	11	15	8	16	9	4	
Species	n years												
Yellow-billed loon	10	17	15	187	60	24	**415**	79	119	39	10	61	1026
		0.0070	0.0072	0.0448	0.0194	0.0061	**0.1480**	0.1087	0.0336	0.0271	0.0049	0.0131	0.0334
Pacific loon	10	1114	2277	3200	**3408**	2471	2167	416	1639	1187	792	2236	20906
		0.4624	1.0854	0.7655	**1.1072**	0.6362	0.7723	0.5698	0.4618	0.8188	0.4061	0.4837	0.6798
Red-throated loon	10	355	167	240	89	**458**	400	103	200	146	332	401	2892
		0.1473	0.0796	0.0575	0.0289	0.1180	0.1425	0.1418	0.0564	0.1006	**0.1705**	0.0867	0.0940
Jaegers	10	338	299	469	376	**770**	353	89	504	202	292	588	4278
		0.1401	0.1423	0.1122	0.1221	**0.1982**	0.1257	0.1219	0.1421	0.1394	0.1498	0.1272	0.1391
Glaucous gull	10	774	612	1113	1213	2153	1734	216	909	399	832	**2209**	12162
		0.3214	0.2916	0.2662	0.3940	0.5542	**0.6179**	0.2955	0.2560	0.2753	0.4267	0.4779	0.3955
Sabine's gull	10	43	157	1072	**1194**	848	868	229	698	321	784	183	6397
		0.0180	0.0748	0.2565	0.3880	0.2182	0.3094	0.3135	0.1967	0.2214	**0.4019**	0.0396	0.2080
Arctic tern	10	137	385	**2509**	1144	526	1773	288	1672	358	374	425	9590
		0.0569	0.1834	0.6003	0.3716	0.1354	**0.6317**	0.3950	0.4712	0.2467	0.1919	0.0919	0.3118
Red-breasted	10	5	25	**111**	24	10	57	0	23	10	0	54	319
Merganser		0.0020	0.0118	**0.0265**	0.0078	0.0025	0.0204	0.0000	0.0066	0.0068	0.0000	0.0118	0.0104
Mallard	10	0	9	14	0	19	29	0	45	34	16	**78**	244
		0.0000	0.0045	0.0033	0.0000	0.0049	0.0102	0.0000	0.0127	**0.0236**	0.0084	0.0168	0.0079
American wigeon	10	19	5	38	14	33	38	3	48	12	44	**202**	456
		0.0078	0.0025	0.0090	0.0047	0.0085	0.0136	0.0036	0.0135	0.0086	0.0226	**0.0437**	0.0148
American green-	10	**67**	30	52	43	65	20	0	38	23	63	39	438
winged teal		0.0278	0.0141	0.0124	0.0138	0.0167	0.0069	0.0000	0.0108	0.0156	**0.0322**	0.0085	0.0142
Northern shoveler	10	20	15	24	0	24	29	10	14	9	**45**	89	280
		0.0083	0.0070	0.0057	0.0000	0.0063	0.0104	0.0137	0.0040	0.0063	**0.0233**	0.0192	0.0091
Northern pintail	10	2969	3131	5035	4918	**13486**	3435	838	3380	1735	9900	5645	54472
		1.2329	1.4920	1.2045	1.5979	3.4720	1.2240	1.1498	0.9523	1.1968	**5.0782**	1.2212	1.7712
Greater scaup	10	32	71	688	250	105	**1302**	137	584	91	61	285	3606
		0.0135	0.0338	0.1646	0.0813	0.0270	**0.4640**	0.1872	0.1645	0.0629	0.0314	0.0616	0.1172
Long-tailed duck	10	3212	3908	4456	3074	**4979**	2226	553	2440	1605	1793	4918	33163
		1.3336	**1.8625**	1.0661	0.9987	1.2819	0.7932	0.7585	0.6874	1.1071	0.9195	1.0639	1.0783
Steller's eider	10	0	14	52	5	**84**	9	0	0	0	21	0	185
		0.0000	0.0067	0.0125	0.0015	**0.0215**	0.0033	0.0000	0.0000	0.0000	0.0110	0.0000	0.0060
Spectacled eider	9	341	1067	822	1193	**1436**	393	157	61	211	625	758	7065
		0.1417	**0.5085**	0.1967	0.3877	0.3696	0.1402	0.2156	0.0172	0.1454	0.3207	0.1640	0.2297
King eider	9	362	454	1782	1727	638	397	203	2226	1769	355	3000	12913
		0.1502	0.2164	0.4263	0.5612	0.1641	0.1416	0.2788	0.6273	1.2198	0.1820	0.6491	0.4199

Table 6. Continued.

Stratum description		Wainwright coastal margin	Atqasuk - Kuk River Lake Region	Upper Meade River	Lower Meade River	Barrow - Cape Franklin - Icy Cape	Topagoruk and Chipp Rivers	Western Northeast Planning Area	Middle Northeast Planning Area	Kogru River	Northern Northeast Planning Area	Colville Delta to Sagavanirtok River	Total North Slope Eider survey
Stratum km^2		2408.2	2098.3	4179.7	3077.9	3884.2	2806.2	729.2	3549.3	1450	1949.5	4622.5	30755
Map reference		7	1	14	6	2	11	15	8	16	9	4	
Species	n years												
Black scoter	10	5	0	19	5	26	5	0	71	3	5	11	149
		0.0019	0.0000	0.0046	0.0015	0.0066	0.0017	0.0000	0.0199	0.0023	0.0025	0.0024	0.0048
White-winged	10	0	0	29	9	0	14	9	**228**	0	2	5	296
scoter		0.0000	0.0000	0.0069	0.0030	0.0000	0.0051	0.0123	**0.0641**	0.0000	0.0012	0.0010	0.0096
Snow goose	10	59	2	0	17	383	63	0	2	35	181	**874**	1617
		0.0244	0.0011	0.0000	0.0054	0.0985	0.0226	0.0000	0.0006	0.0243	0.0928	**0.1891**	0.0526
White-fronted	10	4516	5609	7008	8281	6676	7644	2222	5305	3446	6024	**10990**	67723
goose		1.8752	2.6733	1.6767	2.6904	1.7189	2.7241	3.0472	1.4948	2.3768	**3.0902**	2.3775	2.2020
Canada goose	10	17	17	133	63	702	134	23	159	192	**7493**	906	9838
		0.0069	0.0081	0.0319	0.0205	0.1807	0.0476	0.0311	0.0448	0.1326	**3.8433**	0.1959	0.3199
Black brant	10	179	34	26	108	637	178	30	74	232	**1465**	853	3815
		0.0745	0.0163	0.0062	0.0350	0.1639	0.0635	0.0405	0.0208	0.1599	**0.7514**	0.1844	0.1240
Tundra swan	10	189	303	351	514	798	1076	247	777	343	529	**1123**	6250
		0.0785	0.1442	0.0840	0.1671	0.2053	**0.3835**	0.3380	0.2190	0.2368	0.2714	0.2429	0.2032
Sandhill crane	10	10	10	0	7	10	**20**	0	12	0	**20**	12	101
		0.0041	0.0049	0.0000	0.0023	0.0025	0.0070	0.0000	0.0034	0.0000	**0.0104**	0.0025	0.0033
Unident. small	5	2628	4560	5896	7144	**10049**	4773	1177	3710	1856	3629	2548	47970
shorebird		1.0914	2.1734	1.4105	2.3210	**2.5871**	1.7008	1.6141	1.0452	1.2800	1.8617	0.5513	1.5597
Short-eared owl	10	5	0	9	5	5	12	0	**31**	5	7	12	90
		0.0019	0.0000	0.0022	0.0016	0.0012	0.0042	0.0000	**0.0086**	0.0037	0.0036	0.0026	0.0029
Snowy owl	10	33	10	17	31	**457**	46	8	13	30	89	138	873
		0.0136	0.0048	0.0040	0.0100	**0.1177**	0.0165	0.0114	0.0037	0.0208	0.0456	0.0299	0.0284
Common raven	10	2	2	5	3	0	12	0	8	0	0	**36**	68
		0.0010	0.0011	0.0011	0.0008	0.0000	0.0043	0.0000	0.0023	0.0000	0.0000	**0.0078**	0.0022

Table 7. Average log-linear slopes, population growth rates and years to detect a population trend equivalent to a 50 percent growth or decline in 10 years, for observations of selected bird species in early to mid-June 1992-2001 sampling North Slope wetlands, Alaska. Variance estimates used were based on within-year sampling error among transects as stratified by 11 physiographic regions.

Species	Measure	Years	n years	Log-linear Slope	T-test probability of slope = 0	Mean Population Growth Rate	Mean Population Growth Rate 90% CI	Avg. Sampling error Coef. of Variation	Years to detect a Slope of 0.069
Yellow-billed loon	S + 2*Pr+FL	1992-2001	10	-0.0184	0.4008	0.9817	0.9488 - 1.0159	0.226	10.3
Pacific loon	S + 2*Pr+FL	1992-2001	10	0.0101	0.6940	1.0101	0.9699 - 1.0520	0.065	4.5
Red-throated loon	S + 2*Pr+FL	1992-2001	10	-0.0975	0.0428	0.9071	0.8486 - 0.9697	0.153	7.9
Jaeger spp.	S + 2*Pr+FL	1992-2001	10	0.0395	0.4200	1.0403	0.9638 - 1.1228	0.120	6.7
Glaucous gull	S + 2*Pr+FL	1992-2001	10	0.0197	0.5451	1.0199	0.9689 - 1.0737	0.161	8.2
Sabine's gull	S + 2*Pr+FL	1992-2001	10	-0.0309	0.4199	0.9696	0.9133 - 1.0293	0.136	7.3
Arctic tern	S + 2*Pr+FL	1992-2001	10	0.0720	0.0004	1.0747	1.0534 - 1.0964	0.110	6.4
Red-breasted merganser	2*(S+Pr)+Fl	1992-2001	10	0.0982	0.2611	1.1032	0.9652 - 1.2608	0.471	16.8
Northern shoveler	2*(S+Pr)+Fl	1992-2001	10	0.2235	0.2688	1.2504	0.9177 - 1.7038	0.390	14.8
Northern pintail	2*(S+Pr)+Fl	1992-2001	10	0.0381	0.4697	1.0389	0.9565 - 1.1284	0.091	5.6
Greater scaup	S + 2*Pr+FL	1992-2001	10	0.0433	0.1720	1.0443	0.9958 - 1.0951	0.204	9.6
Long-tailed duck	2*(S+Pr)+Fl	1992-2001	10	0.0141	0.3334	1.0142	0.9916 - 1.0374	0.066	4.5
Spectacled eider	2*(S+Pr)+Fl	1993-2001	9	-0.0186	0.5060	0.9820	0.940 - 1.0250	0.139	7.4
king eider	2*(S+Pr)+Fl	1993-2001	9	0.0302	0.1857	1.0306	0.9964 - 1.0661	0.133	7.2
Steller's eider	2*(S+Pr)+Fl	1992-2001	10	0.1095	0.6104	1.1160	0.7940 - 1.5670	0.390	14.8
White-winged scoter	2*(S+Pr)+Fl	1992-2001	10	0.1494	0.3006	1.1611	0.9299 - 1.4498	0.549	18.6
Snow goose	S + 2*Pr+FL	1992-2001	10	0.1518	0.1990	1.1639	0.9738 - 1.3910	0.557	18.7
Gr. White-fronted goose	S + 2*Pr+FL	1992-2001	10	0.0348	0.3324	1.0354	0.9796 - 1.0944	0.082	5.2
Canada goose	S + 2*Pr+FL	1992-2001	10	-0.0711	0.2595	0.9313	0.8457 - 1.0256	0.326	13.1
Black brant	S + 2*Pr+FL	1992-2001	10	0.1023	0.0658	1.1077	1.0236 - 1.1988	0.309	12.7
Tundra swan	S + 2*Pr+FL	1992-2001	10	0.0349	0.1625	1.0355	0.9976 - 1.0748	0.124	6.9
Unident. small shorebird	S + 2*Pr+FL	1997-2001	5	0.0150	0.8502	1.0151	0.9002 - 1.1448	0.064	4.5
Short-eared owl	S + 2*Pr+FL	1992-2001	10	0.2121	0.1815	1.2362	0.9741 - 1.5689	0.248	10.9
Snowy owl	S + 2*Pr+FL	1992-2001	10	-0.1729	0.2028	0.8413	0.6854 - 1.0326	0.357	13.9

1. S = single, Pr = pair, Fl = flocked birds not in discernable pairs.

APPENDIX 1. Common and scientific names of species listed in this report.

Common Name	*Scientific Name*
Yellow-billed loon	*Gavia adamsii*
Pacific loon	*Gavia pacifica, G. arctica*
Red-throated loon	*Gavia stellata*
Jaeger spp.	*Stercorarius pomarinus, S. parasiticus, S. longicaudus*
Glaucous gull	*Larus hyperboreus*
Sabine's gull	*Xema sabini*
Arctic tern	*Sterna paradisaea*
Mallard	*Anas platyrhynchos*
American wigeon	*Anas americana*
Am. green-winged teal	*Anas crecca*
Northern shoveler	*Anas clypeata*
Northern pintail	*Anas acuta*
Red-breasted merganser	*Mergus serrator*
Scaup spp.	*Aythya marila, A. affinis*
Long-tailed duck	*Clangula hyemalis*
Spectacled eider	*Somateria fischeri*
Common eider	*Somateria mollissima*
King eider	*Somateria spectabilis*
Steller's eider	*Polysticta stelleri*
White-winged scoter	*Melanitta fusca*
Snow goose	*Chen caerulescens*
White-fronted goose	*Anser albifrons*
Canada goose	*Branta canadensis*
Black brant	*Branta bernicla*
Tundra swan	*Cygnus columbianus*
Sandhill crane	*Grus canadensis*
Snowy owl	*Nyctea scandiaca*
Common raven	*Corvus corax*

Common Name	*Scientific Name*
Black-bellied plover	*Pluvialis squatarola*
Lesser golden plover	*Pluvialis dominica*
Bar-tailed godwit	*Limosa lapponica*
Hudsonian godwit	*Limosa haemastica*
Whimbrel	*Numenius phaeopus*
Red-necked phalarope	*Phalaropus lobatus*
Red phalarope	*Phalaropus fulicaria*
Long-billed dowitcher	*Limnodromus scolopaceus*
Ruddy turnstone	*Arenaria interpres*
Dunlin	*Calidris alpina*
Semipalmated sandpiper	*Calidris pusilla*
Pectoral sandpiper	*Calidris melanotos*

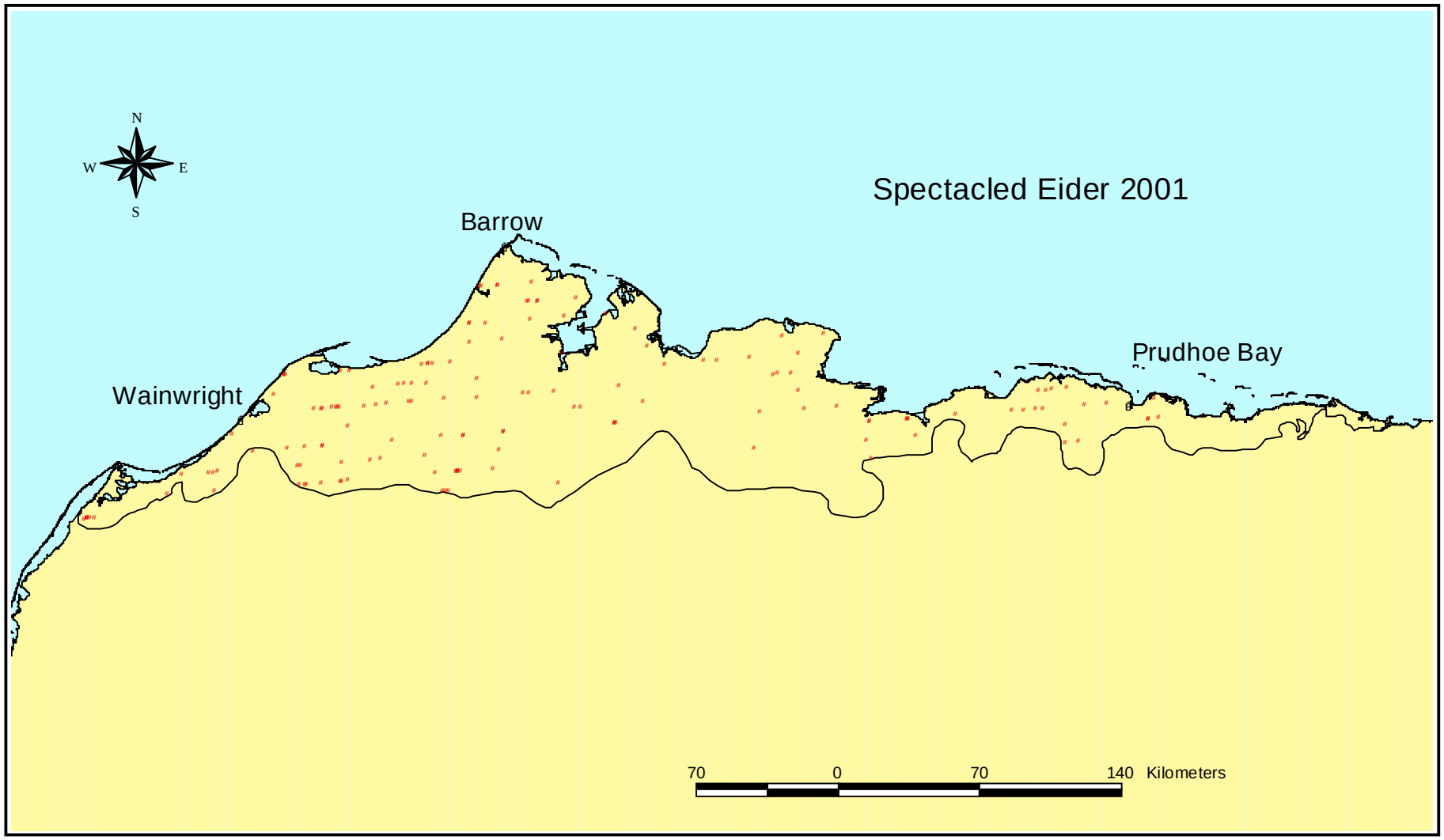

Figure 5. Locations of spectacled eiders observed during aerial surveys of the arctic coastal plain of Alaska, June, 2001.

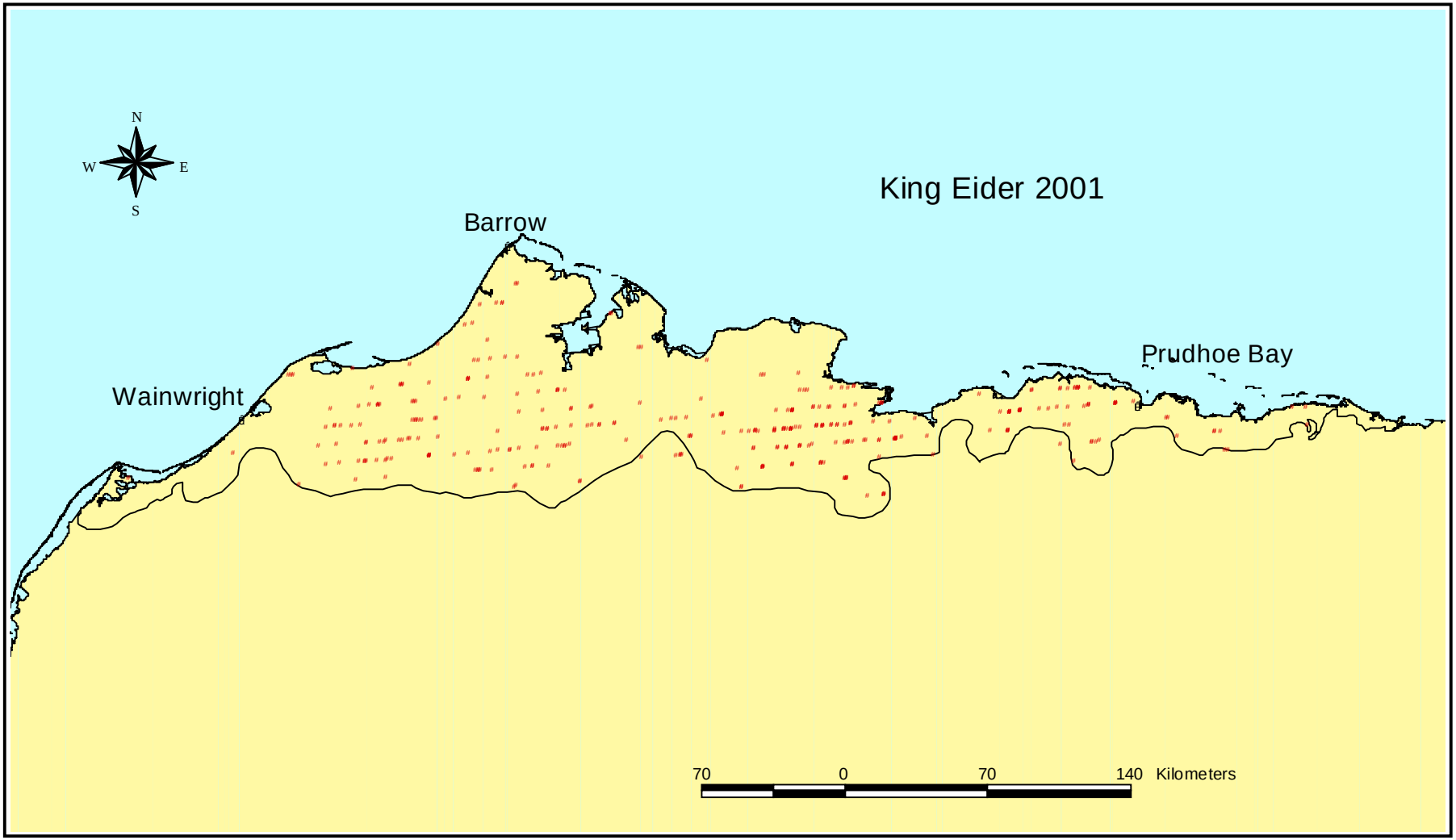

Figure 6. Locations of king eiders observed during aerial surveys of the arctic coastal plain of Alaska, June 2001.

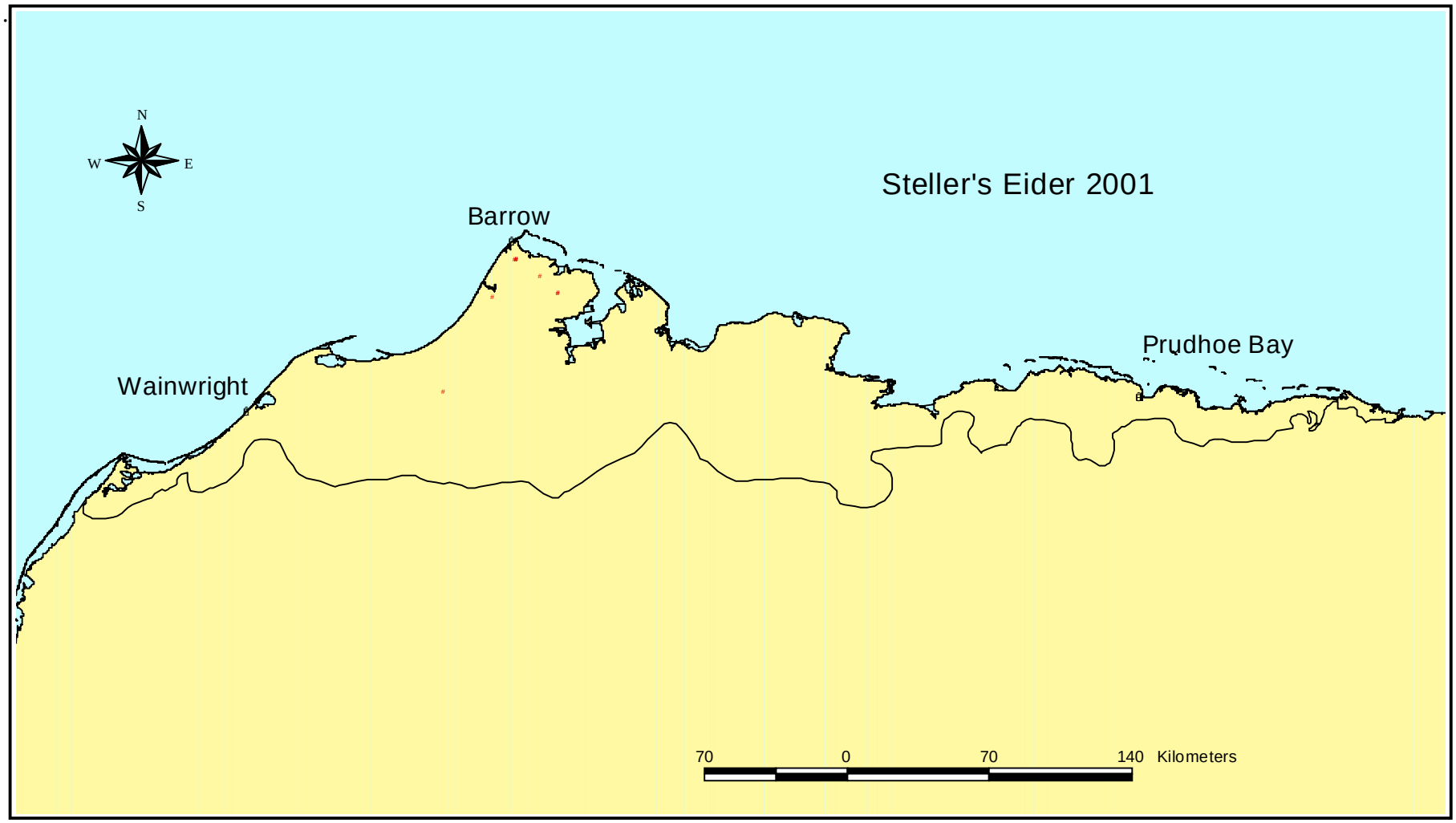

Figure 7. Locations of Steller's eiders observed during aerial surveys of the arctic coastal plain of Alaska, June, 2001.